How Harsh Environments Affect Grease Life

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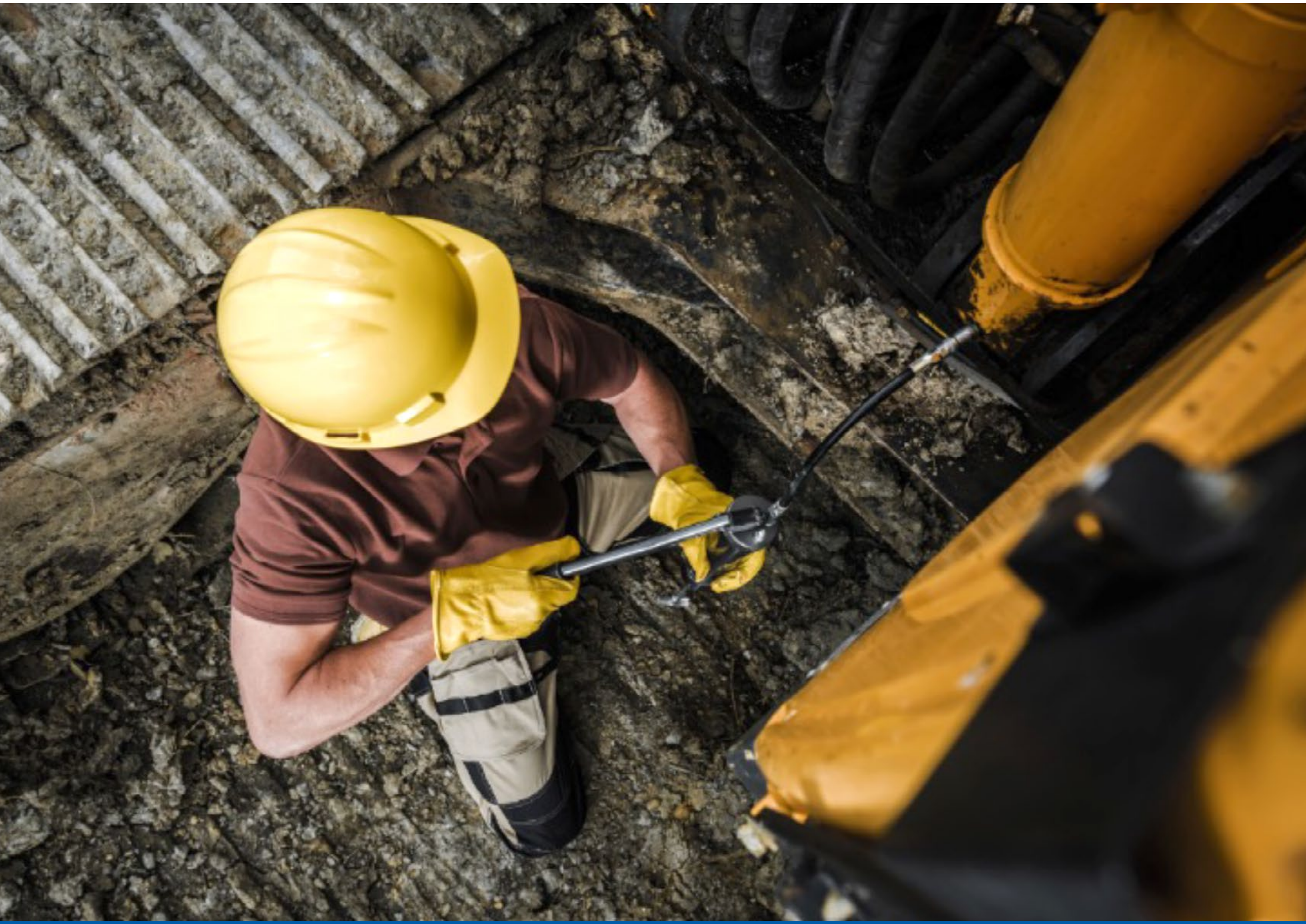


A grease's environment plays a significant role in its longevity. Temperature abnormalities and extremely wet or dusty surroundings can all have detrimental effects on lubrication. It's also quite common for machines to experience more than one of these conditions at a time. Therefore, it's important to consider your grease's surroundings when maintenance is performed to help minimize downtime and increase reliability.

It is often stated that lubricants should be kept clean, cool, and dry—to keep lubricants in this condition, it's important to consider a variety of factors from maintaining a clean storage and handling space to optimizing regreasing practices. Let's dive into a few of the ways extreme operating conditions affect lubrication and what you can do to mitigate their effect.

Dirty Environments

Dirty and dusty work environments provide opportunities for particle contamination. Particles can gain access to exposed grease or through open ports and hatches, faulty or worn seals, or other openings. Once contained in the grease, particles cause mechanical wear through surface abrasion, fatigue, and adhesion. Particle wear can account for as much as 80 percent of the wear that will occur over a machine's lifetime.

For example, truck fleets that run local or short-distance routes generally translate to more frequent trailer hookups and detachments, often multiple in a day in a variety of conditions including road grime, salt, and other debris that can meet the vehicle's grease, diminishing it. Demands like this call for a heavy-duty grease that holds firm and doesn't need to be reapplied several times throughout the day.

Wet Conditions

Equipment that is subjected to wet conditions can also experience lubrication-related failures. When moisture appears in lubricants, it can take three different forms: emulsified, dissolved, and free. The specific form will depend on the amount of moisture, the lubricant, and the application. Over time, moisture can affect oxidation, lubricant film strength and load-carrying ability, among other parameters. The moisture can cause grease to wash out of a bearing or can dilute the grease and alter its consistency, reducing its lubricating abilities. ASTM D4049, a water spray-off test, is performed to determine a grease's resistance to water sprays.

Temperature

Temperature extremes, on both the high and low ends, as well as temperature fluctuations, can negatively affect greases that aren't explicitly designed to handle these conditions. Additionally, temperature affects a grease's base oil viscosity, one of its most important qualities.

High Temperatures

Once a lubricant has exceeded its maximum allowable temperature, it will degrade at double-speed for every 10° F increase in temperature. Excessive heat generation can result from over-greasing or under-greasing bearings. Too much grease causes the machine to work harder—not enough, and the friction between parts generates heat.

A grease's dropping point is the temperature at which it goes from a semi-solid state to a liquid and is determined using ASTM D566 and D2265. The dropping point is a good indicator of a grease's heat resistance but does not necessarily define the grease's useful temperature limit.

Type	Dropping Point, ºC	Maximum Service Temperature, ºC
Simple lithium	175	120 to 135
Lithium complex	≥ 250	150 to 180
Polyurea	≥ 245	150 to 180
Lime soap	90	60 to 70
Anhydrous calcium	140	90 to 110
Calcium complex	≥ 232	130 to 150
Modified clay	≥ 280	190 to 220
Sodium	165	90 to 120
Sodium complex	≥ 250	150 to 180
Aluminum complex	≥ 250	130 to 150
Calcium sulfonate complex	≥ 260	190 to 200

Low Temperatures

Low temperatures are dangerous for grease because they can increase base oil viscosity. Once temperatures drop into the critical zone, grease can stiffen, making it unable to lubricate machine components properly. Knowing and understanding a lubricant's viscosity index can help when choosing a grease for cold applications. Tests including Low Temperature Torque and US Steel Mobility are performed to determine at what temperature a grease is no longer able to allow bearings to rotate smoothly or to be pumped. The following chart shows typical low-temperature limits for different types of grease:

Grease Type	Low-temp Limit, °F
Conventional mineral-oil industrial greases	-30
Low-temperature mineral-oil greases	-50
High temperature silicones	-30
PAO synthetic hydrocarbons	-65
Diester	-80
Special silicones	-110

How to Mitigate the Effects of Harsh Conditions

The most important aspect of using a grease is selecting the right grease for the job and environment. Carefully consider the factors that will affect the grease, and select a grease based on these needs. It is also important to grease at the correct frequency.

Depending on the size of your operation, grease testing may be warranted to determine grease suitability and to detect potential issues with the grease or application. Grease testing can be performed in your facility or at a third-party laboratory.

Properties of High-Temperature Grease

When comparing temperatures, "high" is a relative term. Bearings in a roll-out table at a steel mill may experience sustained temperatures between 250 F and 300 F, sometimes experiencing even higher process temperatures. The bearings of the conveyor belts that carry painted metal automotive parts through drying ovens can be consistently exposed to temperatures of 400 F or higher.

Beyond heat resistance, the grease for applications like these would require exceptional load-carrying capabilities, mechanical stability, water-wash resistance, and pumpability. The abilities that a grease possesses lie in the things that make it up: the base oils, thickeners and additives.

Base Oils

Base oils can be categorized as either mineral or synthetic, with mineral oils making up nearly 95 percent of grease manufactured. The American Petroleum Group uses a five-category system to divide base oils.

Group I is comprised of naphthenic and solvent-refined paraffinic petroleum stocks, typically with a high percentage of unsaturated molecules (which can promote oxidation). Group I base oils also contain polar products called heterocycles. These polar products are reactive, but they help dissolve or disperse additives.

Groups II and III are mineral oils that have been submitted to extensive processing to remove reactive molecules and stabilize other molecules by saturating them with hydrogen. This processing can cause these greases to have good oxidative and thermal properties.

Group IV is synthetic hydrocarbons or SHC fluids. These oils are produced by combining two or more small hydrocarbons to create larger molecules. This improves stability but also saddle group IV oils with a high price tag. Group V base oils are those that have defined degradation paths that are not primarily oxidative or thermal.

Grease Consistency and Base Oil Viscosity

A grease's consistency is often confused with viscosity, but these are two different factors, each with its own degree of importance, depending on the application. Viscosity is the measure of an oil's resistance to flow; consistency is the degree to which a grease will resist deformation when force is applied.

Concerning grease, the measurement of consistency is called penetration and differentiates between new grease and grease that has worked or been handled. ASTM D217 and D1403 measure grease consistency using a cone penetration method. The National Lubricating Grease Institute (NLGI) uses a scale ranging from 000 to 6 to grade the consistency of grease:

NLGI Grade Food Comparison

NLGI Grade	Worked Penetration After 60 Strokes at 25 ºC(0.1mm)	Appearance	Food Consistency Comparison
000	445-475	Fluid	Ketchup
00	400-430	Fluid	Applesauce
0	355-385	Very Soft	Brown Mustard
1	310-340	Soft	Tomato Paste
2	265-295	Moderately Soft	Peanut Butter
3	220-250	Semi-Fluid	Vegetable Shortening
4	175-205	Semi-hard	Frozen Yogurt
5	130-160	Hard	Smooth Pate
6	85-115	Very Hard	Cheddar Cheese Spread

This table was originally sourced from a release by National-Spencer, Inc.

The testing of grease consistency is also affected by certain conditions. What follows are five categories of penetration:

- Undisturbed: A grease that is in its original container and has not been used.
- Unworked: A grease sample that was subjected to minor disturbance when being transferred to the test cup.
- Worked: A grease that has undergone 60 double stroked in a standard grease worker. (NLGI classifications are based on the penetration of worked grease.)
- Prolonged Worked: A grease that has been subjected to a specific number of strokes (beyond 60) and then brought to a temperature of 77 F and subjected to another 60 double strokes.
- Block: A grease that is firm enough to hold its shape without a container.

Selecting the Correct Consistency for an Application

High Consistency (Higher NLGI Numbers)

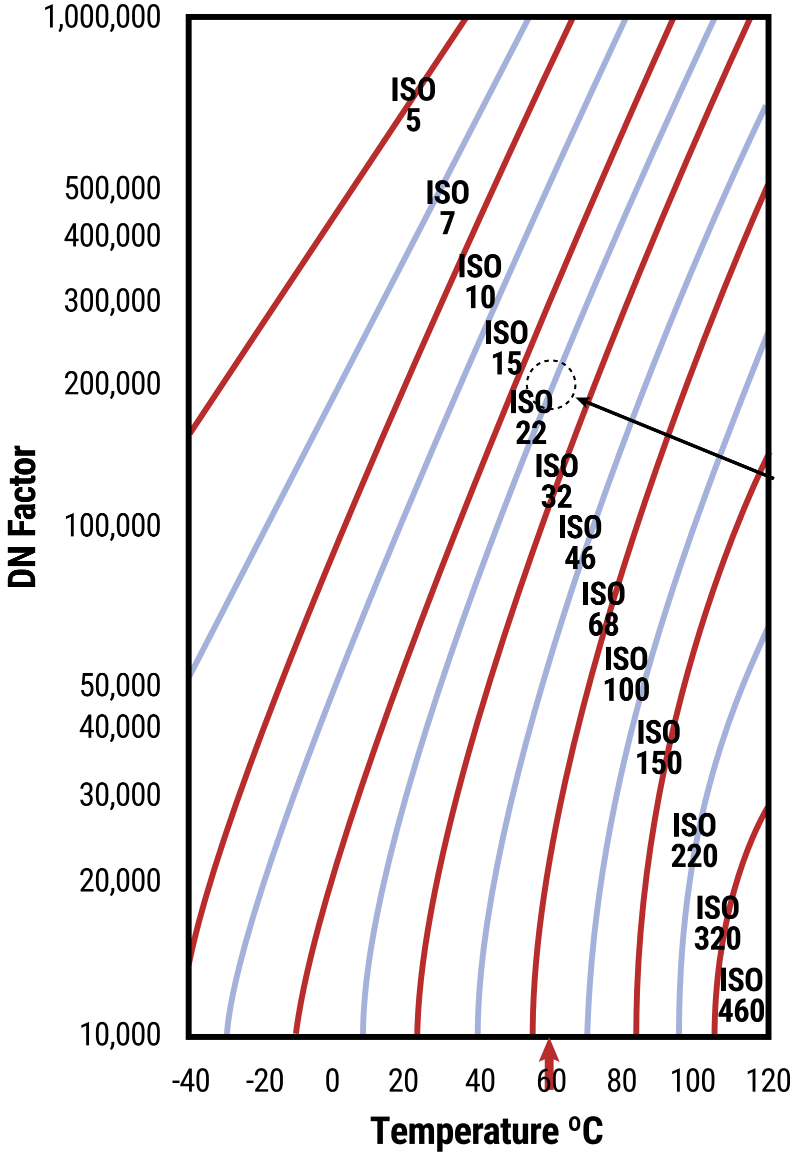
- Journal bearings, slow speed, such as locomotive block grease
- High-speed ball/roller bearings (with low-viscosity base oil)
- To avoid water washout
- To avoid bleed
- To avoid excessive leakage problems
- High ambient or operating temperatures
- To seal out environmental dust (very dusty conditions)

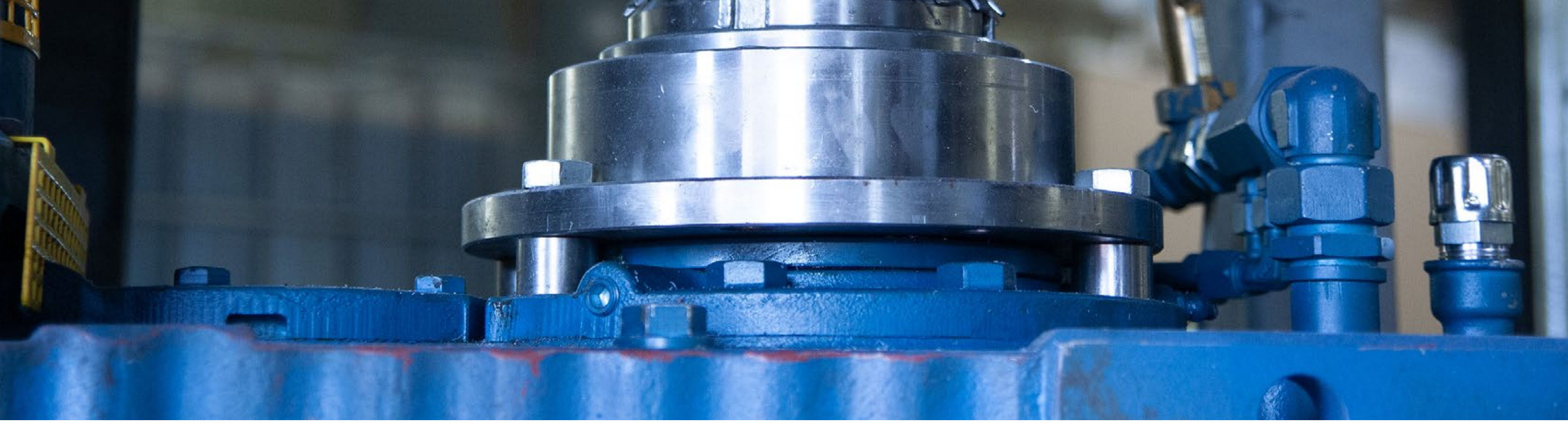
For some applications, especially the greasing of elemental bearings, viscosity is just as, if not more important, than consistency. Most methods used to determine the minimum and optimum viscosity requirements for bearing greases use speed factors, which are usually denoted as DN or NDm. The following formulas are used:

DN = (rpm)*(bearing bore)

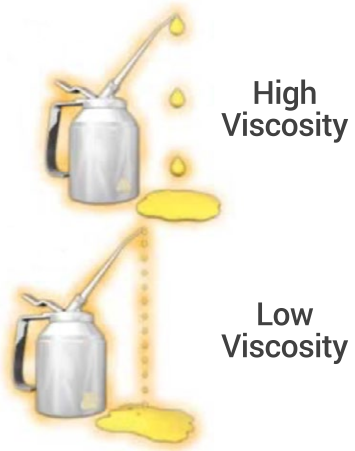
NDm = rpm*((bearing bore + outside diameter)/2)

Once the speed value factor is obtained, it can be combined with the likely operating temperature to determine the minimum viscosity requirement. Charts like the following are quick ways to make this determination when the aforementioned factors are known:





Thickeners



Many different materials, both organic (such as polyurea) and synthetic (such as clay or fumed silica, or a soap/complex soap, like lithium or calcium sulfonate), can be used to thicken the base oil into the required grease consistency.

While the entire package determines a grease's usefulness over time, the thickener material can affect the grease's temperature stability.

Additives

Additives used in greases provide application-specific performance enhancement. Like the thickener, the qualities of the additive alone do not matter as much as the qualities present when combined with the other components of the grease. Additives commonly provide oxidation stability, water resistance, wear resistance, temperature flow stabilizers and more.

Conclusion

The need for heavy-duty greases is amplified in dirty environments and applications with extreme temperatures. These environments are extremely demanding on machinery, and choosing the right grease and implementing it properly optimizes machine performance and extends asset longevity. Avoid unnecessary machine failure by taking the time to determine the right grease for your operations.

Mystik® JT-6® Heavy Duty SynBlend 460 #2 Grease is a high-performance grease designed for a wide variety of heavy-duty applications. It is a premium lithium complex thickener system utilizing an optimized blend of mineral and synthetic base oils for a wide operating temperature range and superior performance properties.

Mystik JT-6 Heavy Duty SynBlend 460 #2 Grease exhibits exceptional wear control, extreme high EP performance, provides excellent water resistance and superior corrosion protection in the most adverse conditions in the presence of freshwater and saltwater.